Climate change and uncertainty avoidance in spatial planning: Illuminated through environmental assessment of spatial plans

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Uncertainty is an unavoidable part of spatial planning and related predictions, e.g. of environmental impacts of plan implementation. The uncertainty premise embedded in planning is highly relevant and critical for climate change. But how well is uncertainty handled in planning practice? This paper concerns the handling and non-handling of climate change uncertainties in spatial planning - by using the explicit consideration of uncertainty within the mandatory Strategic Environmental Assessment (SEA) of spatial plans as an indicator. This paper suggests that uncertainty it not handled very well, and goes on to suggest a set of reasons for avoiding uncertainty.

1 Introduction: Climate change in spatial planning

In the fourth assessment by the IPCC climate change is defined as "*a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity*" (Bernstein et al. 2007, p. 30). Present and future climate change is currently assessed by the IPCC as real and probably caused by society's increasing emissions of GHGs (Barker et al. 2007). Climate change is expected to have various consequences on a global scale, some of these are rising sea levels, changes in precipitation patterns and pressure on ecosystems (Bernstein et al. 2007), which will also result in pressure on urban areas and development.

There are two overall approaches which society could adopt to counter the negative effects of climate change; Mitigation and adaptation. Bernstein et al. (2007, p. 56) describe mitigation as follows: "*Societies can respond to climate change by adapting to its impacts and by reducing GHG emissions (mitigation), thereby reducing the rate and magnitude of change*". Previously the focus has primarily been on reduction of GHG emissions, but in recent years more attention has been paid to the necessity of adaptation, which is described as follows: "*adaptation measures will be required at*

regional and local levels to reduce the adverse impacts of projected climate change and variability, regardless of the scale of mitigation undertaken over the next two to three decades" (Bernstein et al. 2007, p. 56).

Climate change is increasingly becoming a concern in spatial planning. As stated by Biesbroek et al (2009) "*both mitigation and adaptation has a spatial dimension*". Bulkeley (2006) seconds this by stating "*that there is a growing sense that spatial planning not only has an important role in addressing the causes and impacts of climate change, but that it is increasingly required to do so*". Spatial planning deals with e.g. land use, transport, water and housing, all issues which are linked to climate change mitigation and adaptation. For example Bulkeley (2006) states that "*most of UK emissions fall within the domestic and transport sectors, over which, to date, little action has been taken and within which spatial planning has a key role to play. Likewise, the predicted impacts of climate change—of storms, flood events, sea level rise, and changes in biodiversity—are issues about which spatial planning decisions can effect vulnerability and resilience to change.*" The *Stern Review* from 2006, emphasises the role of land-use planning in encouraging adaptation to climate change in buildings and infrastructure.

An important issue is the uncertainty connected with determining both present and future climate change. The Meteorological Institute of Denmark (n.d.b) state that "*in practice it is a very difficult task since the climate models are not nearly detailed enough to describe all elements of the real world*". The IPCC explicitly addresses and categorises uncertainty. In relation to climate changes there is a focus on scientific uncertainty, for example in relation to feedback mechanisms in the carbon cycle or changes in ice flow. In relation to responses to climate change the IPCC also delves into the uncertainties related to how planners will integrate knowledge of climate change in their decision, and what the institutional, political and financial constraints for adaptation will be. (Bernstein et al. 2007) From this it is also evident that uncertainty is mainly an issue in relation to adaptation, because this is reliant on a prediction of changes in highly complex systems. As Lempert and Schlesinger (2000, 387) point out, when dealing with predictions of consequences of climate change there are two sources of uncertainty and complexity, "*the immensely complex climate system and its related ecosystems*" and "*the state of society fifty and a hundred years hence*". Mitigation on the other hand is reliant on our knowledge of greenhouse gas emissions from specific activities which is less uncertain although not uncomplicated.

Thus different discussions have raised the expectation that spatial planning have a potential for dealing with climate change, both in terms of mitigating climate change

and adapting to it. However, it has been questioned whether spatial planning is living up to this potential, and entailing action on climate change to the expected extent (Bulkeley 2006; Levett 2006; Robinson 2006). One of the characteristics of climate change is the uncertainty and complexity connected to especially its consequences. This is a relevant aspect especially for adaptation in spatial planning, in terms of the uncertainty of what consequences climate change will have on our plans and cities and hence what we are adapting to. This can be viewed as one of the challenges for integrating climate change considerations in spatial planning. Halsnæs (2006) supports this when raising the lack of relevant, detailed data as a critical issue for the ability of spatial planning to deal with climate change.

Based on this, the paper will explore how uncertainty is handled in spatial planning. Since climate change and the related uncertainties are not legally required to be considered in spatial planning in Denmark, we have used the mandatory SEA of spatial plans as a point of departure.

2 Strategic environmental assessment as a framework for addressing climate change uncertainty

In describing strategic environmental assessment, a point of departure is taken in the EU framework for assessment, which is set in the *Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment* (Directive 2001/42/EC 2001). The directive is based on a model for assessment which is the base for SEA systems worldwide, and thus it is deemed a good representative.

Strategic environmental assessment (SEA)

According to the EU directive, an environmental report is to be prepared for certain plans and programmes (for the sake of simplicity the different forms of strategic actions covered by SEA are from now on referred to as plans). The report should describe and assess the likely environmental impacts of the plan and reasonable alternatives, with the purpose of improving the possibilities of assessing which solutions are most expedient in a sustainability framework. SEA is thus a systematic assessment of the environmental consequences of plans based on a broad concept of the environment, with the purpose of supporting more sustainable decisions at a strategic level, through integrating environmental issues in decision-making (Kørnøv 2001, pp. 3-6; Kørnøv and Christensen 2005, pp. 345-6; Therivel 2004, p. 7). Thus, one of the possible results of SEA is delivering information to decision-makers, describing complexities and consequences, allowing them to use this when making their decisions (Therivel 2004, p. 15). Also, SEA is perceived as an instrument for providing more transparency and public participation around environmental issues in an otherwise often

closed and complex political decision-making process (Kørnøv 2001, p. 7; Therivel 2004, p. 17).

Climate change in SEA

Climate change is one of the environmental issues which should be included in SEA according to the EU Directive on SEA. It is stated in the directive that "*the likely significant effects (1) on the environment, including on issues such as biodiversity, population, human health, fauna, flora, soil, water, air,* ***climatic factors****, material assets, cultural heritage including architectural and archaeological heritage, landscape and the interrelationship between the above factors*" should be included in the assessment (Directive 2001/42EC 2001, Annex 1). Further the directive states that assements should focus on assessing the impacts of the plan on the environment, but also include "*any existing environmental problems which are relevant to the plan or programme*" (Directive 2001/42EC 2001, Annex 1). Thus SEA reviews both environmental impacts of the plans and environment impacts on the plan.

The expediency of integrating climate change in SEA is pointed out by Wilson and Piper (2008), who call for an integration of climate change in SEA to promote mitigation of and adaptation to climate change. Further Larsen and Kørnøv (2009) argue for integration of climate change in SEA particularly in the case of river basin management plans, and point out different approaches that should be considered, among these mitigation and adaptation.

From the above it is apparent that SEA is a framework for taking into consideration climate change, both in terms of:

1. Mitigation meaning the impacts of the plan on climate change in terms of what emissions of greenhouse gasses it will result in and how this can be counteracted
2. Adaptation meaning the impacts of climate change on the plan and assessment and how it can be adapted to these impacts.

Uncertainty in SEA

As discussed in the introduction to this paper, climate change is an issue with a lot of uncertainty and complexity connected to it.

The EU directive on SEA states that the assessment should include "*a description of how the assessment was undertaken including any difficulties (such as technical deficiencies or lack of know-how) encountered in compiling the required information*" (Directive 2001/42EC 2001, Annex 1). This signals openness, an acceptance that difficulties occur

during assessment, for example uncertainty, and a demand to address it. As stated by Therivel (2004, p.146), "*the aim of SEA is to reduce uncertainty where it makes sense to, and otherwise to record it, and cope with it*". It furthermore signals the importance of communicating uncertainty to decision-makers and the public. Tennøy, Kværner and Gjerstad (2006) have investigated the handling of uncertainty in impact assessment at the project level, and emphasise a need to address and communicate uncertainty.

As such SEA is a potential tool for addressing the uncertainty and complexity of climate change in planning. In the European context, integration of climate change in SEA is legally required, and planning authorities are obliged to consider and communicate through the report uncertainties involved in the assessment. It is the only legal framework for climate change integration in planning, and is taken as an expression of how environmental issues are handled in planning.

3 Aim and approach

For this paper Denmark and Danish SEA is used as a case. The paper presents results from a study of 125 Danish SEA reports prepared for comprehensive municipal spatial plans and local spatial plans.

The reports were chosen on the basis of the following parameters:

- Type of plan: covering both comprehensive municipal plans and the local plans
- Region of origin: covering all the geographical regions in Denmark
- Year of publication: covering the time from the implementation of SEA in Denmark in 2004 to the end of 2009

Type of plan	Municipal spatial plan	Local spatial plan
	75 (all)	50

Year of publication	2004	2005	2006	2007	2008	2009
	3	14	10	11	13	74

Figure 1 Characteristics of the SEA reports included in the study

The reports have been chosen with an aim to include various characteristics. However, for the comprehensive municipal spatial plans, all published environmental reports are included in the study for the sake of completeness. Regarding the time of

publication, figure 1 shows a majority of reports from recent years. This is because very few reports were published in the first years after SEA became mandatory in Denmark in 2004. The choice to include all municipal spatial plans also affects this, because the majority of these were published in 2009.

The reports were analysed in terms of climate integration and uncertainty. For this article it is of interest that any occurrences of climate change issues were registered as well any consideration of uncertainty regarding climate change. This analysis, of climate change and uncertainty in SEA reports, is used as an indicator of how these issues are handled in planning. However, it should be considered that there may be worked with these issues beyond what is documented in the SEA reports. Still, the SEA reports are deemed as a good indicator of the level of focus on climate change and uncertainty in planning. The results of the analysis are presented in section 4.

4 Handling of uncertainty in SEA

As shown in figure 2, the analysis of SEA reports shows that approximately half of the reports mention climate change. This is mainly the SEA reports of the comprehensive municipal spatial plans from which 79% consider climate change. As figure 3 shows, the aspect of climate change which is mostly dealt with is mitigation. Adaptation is less frequently dealt with and only in the comprehensive municipal spatial plans.

		Case			
		Municipal spatial plan	Local spatial plan		**Total**
Climate	No	16	42		**58**
	Yes	59	8		**67**
	Total	**75**	**50**		**125**

Figure 2 Number of SEA reports that consider climate change

		Case			
		Municipal spatial plan	Local spatial plan		**Total**
Climate	Mitigation	53	8		**61**
	Adaptation	21	0		**21**

Figure 3 Number of SEA reports that deal with climate change mitigation and adaptation

Despite the fact that approximately half of the reports deal with climate change, figure 3 shows that only three of the reports deal with issues of uncertainty connected to climate change. This can be related to the fact that the more uncertain adaptation issue is less frequently dealt with in SEA reports, however, the since 21 reports do deal with adaptation, there is a lack of proportions.

	Case			
	Municipal spatial plan	Local spatial plan		**Total**
Uncertainty No	72	50		**122**
Yes	3	0		**3**
Total	**75**	**50**		**125**

Figure 3 Consideration of uncertainty in SEA reports

As figure 3 shows, the reports that consider uncertainty are all municipal spatial plans. The plans are from Hjørring, Struer and Vesthimmerland municipalities. The specific wording of the issues of uncertainty is reviewed below.

Hjørring Municipality: Municipal spatial plan 2009

In this environmental report climate change is mentioned in relation to the environmental baseline: "*since the actual climate changes and the consequences of these for Hjørring Municipality are difficult to predict, among these the level of sea rise, the environmental baseline for climate change is thus subject to uncertainty and only indicates impacts*" (Hjørring Municipality 2009, p. 42).

Struer Municipality: Municipal spatial plan 2009

Like the previous report this environmental report addresses uncertainty of climate change consequences. It is stated that "*the actual climate changes and the consequences of these for Hjørring Municipality are difficult to predict*" and that the quantitative uncertainty means that the environmental baseline is uncertain (Struer Municipality 2009, pp. 29-30).

Vesthimmerland Municipality: Municipal spatial plan 2009

In this environmental report, the same wording as in the report from Hjørring Municipality is used: "*since the actual climate changes and the consequences of these for Vesthimmerland Municipality are difficult to predict, among these the level of sea rise, the environmental baseline for climate change is thus subject to uncertainty and only indicates impacts*" (Vesthimmerland Municipality 2009, p. 30). Also, impacts on climate change in the form of CO_2 emissions are mentioned, since it is added that since these are dependent on the specific implementation, they are difficult to determine at an overall level of planning.

The study reveals that although a significant proportion of the SEAs deal with climate change, almost none adress the uncertainty connected to it. Thus SEA as a potential tool for handling uncertainty and creating transparent about it is not being used.

5 Reasons for avoiding uncertainty

This paper takes the above conclusion as a point of departure for hypothesising about reasons behind handling or not handling climate change in decision making. Our focus in the following is on explanation models for why people avoid uncertainty

That organisations try to avoid uncertainties rather than confronting them is discussed in the organisation literature (see e.g. Cyert and March 1963), which opens up both psychological and social processes of decision-making. From theory on decision-making and organisations, five potential barriers to dealing with uncertainty are proposed: Cognitive limitations, uncertainty itself, avoiding conflict, instilling trust and reliance on quantification.

Cognitive limitations. Cognitive limitations refer to the ability of humans to grasp uncertainty. At times people cannot grasp uncertainty and thus have a need to construct simplifications or satisficing in order to make decisions. This can lead to wholly or partially avoiding complexity and uncertainty. One important explanation is the heuristic involved in coping with uncertainty that was introduced and discussed by Simon (1957) through his work on 'limited rationality'. In line with Simons argument of cognitive limitations, Kahneman and Tversky also underline, that humans need to construct simplifications in order to make decisions: "*In making predictions and judgments under uncertainty, people do not appear to follow the calculus of chance or the statistical theory of prediction. Instead, they rely on a limited number of heuristics which sometimes yield reasonable judgments and sometimes lead to severe and systematic errors"* (Kahneman and Tversky 1973, p. 237). An illustration of this is the satisficing strategy that Simon identified, in which human cognitive resources limit the search for information, tantamount to the focus shifts from maximization to achieving what is perceived as acceptable (Simon 1957). Besides cognitive restraint, simplification can also be forced by limited time.

Uncertainty itself. Uncertainty, due to disagreement in scientific communities about certainty and needed actions, can explain avoidance behavior: "*Uncertainty about climate change probably functions as a justification for inaction or postponed action related to climate change.*" (Swin et al. 2009, p. 125). Uncertainty becomes an acceptable argument – '*if not even the experts can provide clear answers how can we assess the potential impacts and know what to do?*' In line with this argument, Budescu et al. investigates the presentations made by IPCC, and finds that peoples understandings of IPCC's communication of uncertainty leads to different interpretations with resulting lower risk estimation and confusion (Budescu, Broomell and Por 2009) – and thereby non-handling.

Conflict avoidance. Ignoring uncertainty can also be due to conflict situations. Decision-makers need to attain accountability and support for their decisions. Seen in this light uncertainty is threatening to decision-makers, and makes decision-makers vulnerable to criticism and attack (Jaeger et al. 2001, p. 214). Thus decision-makers could ignore uncertainty to avoid opening up for conflicts and opposition to their decisions. Dessai and Sluijs (2007, p. 11) point out the inexpedience of this argument for ignoring uncertainty when they state that not addressing uncertainties leaves "*…policies highly vulnerable to deconstruction in societal discourses and controversies on these policies*". Further they stress that such vulnerability can be used in conflicts by those against a decision (Dessai and Sluijs 2007).

Instilling trust. People and thus decision-makers choose to ignore uncertainty in order to more or less deliberately create a (false) sense of security or trust (Lipshitz and Strauss, 1997). Funtowicz and Ravetz (2005, p. 368) adds to this that "*much of the success of traditional science lay in its powers to abstract from uncertainty in knowledge and values; this is shown in the dominant teaching tradition in science, which created a universe of unquestionable facts, presented dogmatically for assimilation by uncritical students*". Thus science is a basic example of not acknowledging uncertainty in order to instil trust that things are under control.

Reliance on quantification. A perceived need for quantification of uncertainty can be part of the choice of not addressing uncertainty when quantification is not possible. Our propensity to quantify everything is described by Ben-Haim (2006, p. 9) and nicely captured in the statement that "*We are an age of number-givers, and the first advice to a novice in the modern world would be: if it stands still, measure it; if it moves, clock its speed*". Dessai and Sluijs (2007, p. 11) propose that "*The focus on statistical and quantitative methods of uncertainty assessment leads to a tendency to ignore policy relevant uncertainty information about the deeper dimensions of uncertainty that in principle cannot be quantified*". As such people can refrain from dealing with uncertainty because it does not always meet the demand for quantification.

It is clear that this is not an exhaustive list of reasons for not addressing uncertainty, but a range of possible ones. Further some of the reasons listed above are closely related, for example the need for security and the reliance on quantification, which can be seen as part of giving an impression of security.

6 Conclusions

The primary finding in this paper is that SEA practice in relation to spatial planning does not seem to recognise, take into account and communicate problems arising from climate change uncertainty. The analysis reveals that only 5 out of 153 environmental reports have an explicit communication around climate change uncertainties. Thus the SEA is not being used to address uncertainty although it is potentially a tool for this, and presently the only mandatory framework. Through this study it has not been possible to determine whether uncertainty is handled inexplicitly within the SEA and planning process, but not communicated in writing. If this is the case, and the handling of uncertainty is more extensive in practice, it still is problematic to have a practice with inexplicit handling and no transparency regarding uncertainty. By not communicating uncertainties in the SEA reports of spatial plans, they tend to misrepresent certainty, with a risk of both politicians and the public interpreting the impact assessments as more certain than they actually are.

Climate change is viewed as one of the mail challenges for cities and spatial planning today and in the future. With this follows an increased focus on uncertainty and how this is addressed. This paper raises concerns that uncertainty such as that related to climate change may not be very well handled in spatial planning in the Danish context, and urges a discussion about whether this is acceptable and what the reasons are for this. Hereby the paper touches upon critical questions for climate change planning and governance; what strategies and governance conditions needs to be developed in order to handle climate change complexity and uncertainty?

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